Radio Spectrum Measurement Science (RSMS)-4 Development

Outputs

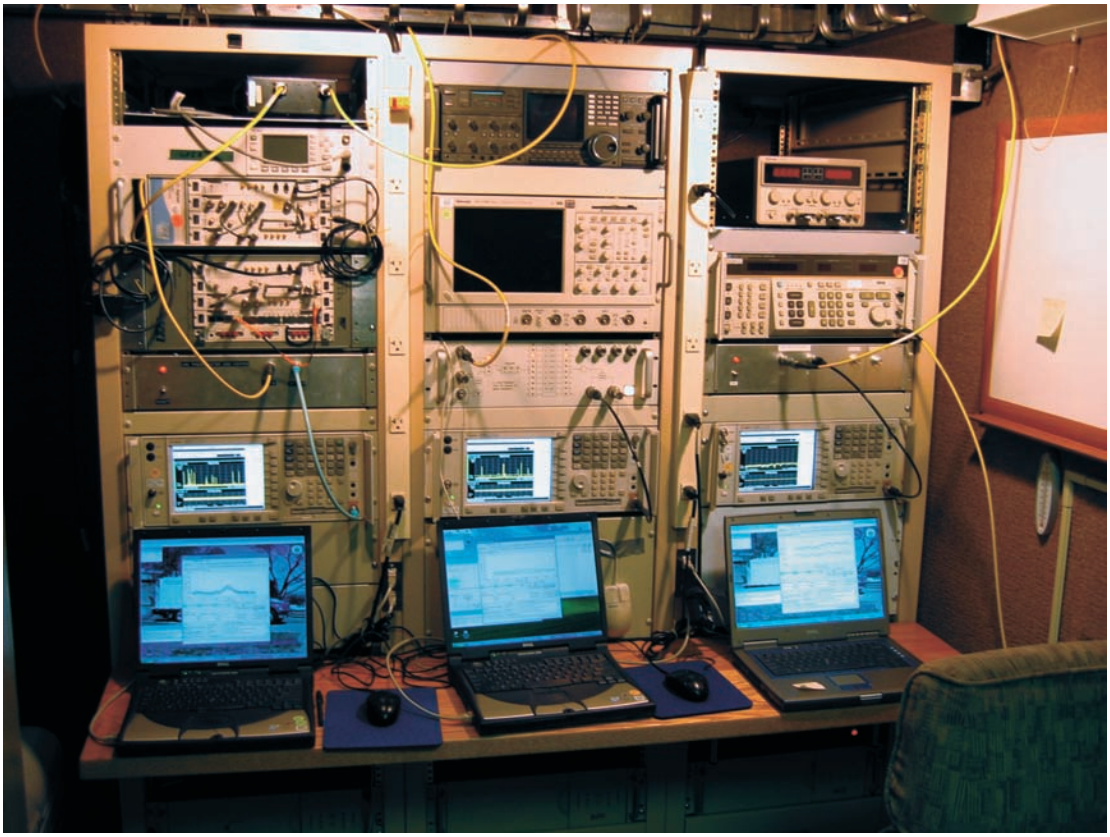
- Two new ITS custom-built preselectors and enhancements of existing preselectors.
- Real-time fully automated direction-finding system that can be used with pulsed signals such as radar.
- Fully automated data acquisition and processing software used for Land Mobile Radio channel occupancy measurements.
- Several new ITS custom-designed software modules for instrument control and measurement.

The 4th generation system for the Radio Spectrum Measurement Science (RSMS) Development project consists of state-of-the-art tools (vehicle, software, and hardware) necessary for making measurements to characterize spectrum occupancy, ensure equipment compliance, determine electromagnetic compatibility, and analyze interference problems. The development of the 4th generation system originated out of the recognized need to upgrade to the latest technology used in RSMS operations. RSMS operations, in turn, directly supports NTIA by providing critical measurement support for determining policies affecting both the public and private sectors. To this end, several new capabilities and improvements have been added to the system in FY 2005.

Integral to the RSMS measurement system has been the development of customized preselector units that filter out unwanted signals and amplify the input to increase system sensitivity. Recently, two new fully functional 4th generation preselectors have been designed and constructed — one for frequencies between 0.5 – 18.0 GHz and the other for frequencies between 18.0 – 26.5 GHz. Both preselectors are protected against strong signals by highly shielded enclosures and are controlled via fiberoptic connections to prevent signals coupling into control lines. In addition to these 4th generation units, several preselectors have been custom-designed specifically for Land Mobile Radio (LMR) measurements. Because the RSMS system has several functional preselectors from previous generations, each of these existing units has also been refurbished and improved upon so as to maintain a large selection of usable devices. Under the development of the 4th generation software, computer automated control of each of the units — new and old — has been integrated into the larger software package. Modularized instrument software units have made it possible to seamlessly swap out preselector units for different applications of the same measurement capabilities.

Currently in progress is the development of real-time "signal direction finding" capabilities. Two student interns, along with ITS engineering staff, have been working together to develop these capabilities through implementation of digital control and processing using Field Programmable Gate Array (FPGA) technology. The system switches through the different antennas of a six-sided array to determine the angle of signal arrival. Using rapid digital processing and a switch control by the FPGA, information is relayed via the Internet to a computer, which can then be used for real-time high-gain antenna positioning toward stationary or moving targets. One of the advantages of this system over most off-the-shelf systems is that it can be used with pulsed signals such as radar. By implementing this system in software as an instrument module, it is easily integrated into the larger RSMS software package for use with a variety of measurement capabilities. Development of this system using FPGA technology will not only provide signal direction finding capabilities but opens up a whole new way of acquiring and processing data using what is essentially a hardware re-programmable instrument that can be used for many different applications.

Recently implemented and used in Washington, DC, and Denver, a fully automated LMR channel occupancy measurement system has been developed by ITS. Using the latest in digital signal processing capabilities, this system simultaneously acquires data on as many as 480 LMR channels, performs processing to remove artifacts, and stores data every second. This new system is an improvement over previous systems in that it can acquire data much more rapidly, and it has enhanced capabilities for removing artifacts such as noise, a wide dynamic



Interior of RSMS 4th generation truck showing setup for LMR measurements taken in the Denver area (photograph by J.R. Hoffman).

range, and because of special processing techniques, a better sensitivity. In addition to the acquisition software, a whole suite of data processing routines have been developed that allow us to look at statistics in ways we have never been able to do before. Because of the versatile nature of the system and the development of a complete set of automated processing routines, application of this system for further measurements in other locations is highly possible and could be implemented efficiently.

Three newly developed additions to the RSMS software include: (1) a rotator instrument control, (2) an azimuth signal search routine, and (3) an enhanced stepped frequency measurement. The rotator instrument control is a software module integrated into the larger RSMS software that allows remote control of an antenna position device. This module can, in turn, be used in combination with a spectrum analyzer control routine for measurements such as the azimuth signal search routine which locates the direction of one or more signal point sources as it sweeps the horizon. The stepped frequency routine is a measurement procedure, used typically for radar measurements, in which the system steps through a narrow bandwidth of frequencies and measures the power. This allows the measurement of signals with a very large dynamic range of power. The FY 2005 enhancement to this routine comprised adding an automated attenuation capability which further increased the capability for measuring wide dynamic ranges.

New features planned for FY 2006 include enhanced data file management, a fully automated swept measurement routine, a swept calibration routine, a yttrium-iron-garnet (YIG) filter calibration routine, a vector signal analyzer instrument control module, two new noise measurement routines, and a scheduler for automated control of multiple measurements.

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